REMARKS

This Reply in response to the Final Office Action mailed October 5, 2004 ("Final Office Action"). This Reply is accompanied by a Request for a two-month Retroactive Extension of Time along with authorization to charge the required statutory fee to Deposit Account No. 50-0951, and a request for continued examination (RCE), as well as a Supplemental IDS. A declaration from Inventor Dr. Shembel ("Declaration") also accompanies this Reply.

Applicants' counsel, the undersigned, acknowledges and appreciates the opportunity to teleconference with the Examiner on November 8, 2004. During the teleconference the undersigned was unable to convince the Examiner that the claimed and for that matter any polymer-based electrolyte can be a single phase solid material comprising a salt, solvent and polymer which are uniformly mixed. Instead, the Examiner insisted that Applicants in fact formed a gel (2-phase) electrolyte, despite Applicants disclosure of a homogeneous solution process to form the electrolyte where the polymer, the salt and an aprotic solvent (plasticizer) are all dissolved in solution using a common low boiling point solvent, which is then removed using a drying process. The Examiner insisted that homogenous solid electrolyte structures including a polymer, salt and solvent were not possible, and the resulting structure must be a gel-based on her experience examining battery related cases.

Applicants suggest that the Examiner review the Declaration before reviewing this Reply, since the Declaration provides clarification to the issues raised by the Examiner, and is referred to frequently in the Reply to minimize redundancy.

Claims 1-25 were pending at the time of the Final Office Action. All claims were rejected. In this Reply, claims 1, 3, 6, and 12-14 have been amended, while claim 2 has been cancelled. No new matter has been added.

Claims 6,7 and 14 were rejected based on lack of proper antecedent basis. The amendment of claims 6 and 14 should overcome these rejections.

Claims 1-25 were rejected under 35 U.S.C. § 112, first paragraph. According to the Examiner:

> the specification, while being enabling for a chlorine containing polymer having an enhanced chlorine level, does not reasonably provide enablement for any halogen containing polymer having an enhanced halogen level.

In response, claims formerly reciting a "halogen containing polymer" have been amended to now recite a "chlorine containing polymer". Accordingly, the 35 U.S.C. § 112, first paragraph rejection noted above has now been overcome.

Claims 1-25 were rejected under 35 U.S.C. § 112, first paragraph for lacking enablement for a homogeneous electrolyte material. According to the Examiner:

Claims 1-25 are rejected under 35 U.S.C. 112, first paragraph, because the specification, while being enabling for a homogeneous solution (single liquid phase) of C-PVC, a salt of an alkali metal and an aprotic solvent, does not reasonably provide enablement for any homogeneous material (single solid phase or single gas phase) of C-PVC, a salt of an alkali metal and an aprotic solvent. The specification does not enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make or use the invention commensurate in scope with these claims. Applicant states the added limitation "as a homogeneous material" is disclosed in the specification at page 21, lines 11-15. However, the specification specifically recites "a substantially homogenous *solution*". Furthermore, this is a product by process claim limitation since the polymer electrolyte of the claimed invention must be a gel electrolyte (heterogeneous solid/liquid phases). Specifically, the modified polymer is a solid material and functions as a separator. The aprotic solvent, by definition, is a liquid. Examiner points out the section cited by Applicant recites "after drying the thin C-PVC film, the film is ready for use in lithium batteries. The film is the solid modified polymer material of the claimed polymer electrolyte. The arguments provided on page 12 of the amendment are contradictory. Specifically, Applicant states "the polymer, the salt and the solvent are homogeneously mixed in solution" and then further states "a 100 mm thick electrolyte layer". The thickness limitation indicates a solid or gel electrolyte layer, not a homogeneous solution.

Applicants respectfully disagree with the enablement rejection above. Applicants provide a paragraph on page 21 of their specification along with 5 Examples (Examples 2-6) which detail how to form a homogeneous solid single phase electrolyte, where all the electrolyte components are uniformly distributed in the electrolyte, using a *homogeneous solution method*. In the *homogeneous solution method*, a modified chlorine comprising polymer, such as C-PVC, is combined with a salt and an aprotic solvent which are together dissolved in a common solvent (e.g. tetrahydrofuran (THF)) which has

a low boiling point to form a substantially homogenous solution. This solution is then dried, preferably under vacuum to remove the common low boiling point solvent.

Clearly, if phase separation does not occur upon drying the homogeneous solution, a single phase homogeneous solid electrolyte results. Applicants' ionic conductivity data provides further evidences of the single phase nature of the claimed solid electrolyte since phase separation would lower ionic conductivity. Paragraph 15 of the Declaration provides sworn testimony that "the high ionic conductivity values obtained provide further evidence of the single phase electrolyte, since phase separation would reduce the ion conductivity towards values provided by conventional gel-electrolytes which are multi-phase structures".

Paragraph 8 of the Declaration provide sworn testimony regarding the structure of Applicants' claimed solid electrolyte and how it is formed. Paragraph 11 of the Declaration provides sworn evidence that " homogeneous solid polymer-based electrolyte films based on other polymers have been known". Published U.S. application No. 20040253520 (assigned to Solicore, Inc.) is cited in the Declaration. Published U.S. application No. 20040253520 discloses a polyimide based solid polymer electrolyte which is described as being a complex of a Li salt and the polyimide.

U.S. Patent No. 5,609,974 to Sun is also referenced in the Declaration. Sun discloses a homogeneous solid polymer electrolyte film without phase separation. Sun forms the homogeneous solid polymer electrolyte film first dissolving an electrolyte salt in a solution including a combination of selected monomers together with a plasticizer and then spreading the solution into a thin layer whereupon the layer is heated or otherwise subjected to a source of energy to effect its polymerization. The polymerization

of this solution results in the formation of a homogeneous solid polymer electrolyte film without phase separation (see the first two paragraphs of the detailed description). The Declaration provides sworn testimony that "Although Sun's method is more complex and quite different as compared to the method disclosed in the present application, the single phase homogeneous solid polymer electrolyte disclosed by Sun comprising polymer, salt and solvent is analogous to the electrolyte claimed in the '556 application in that a single phase electrolyte is provided, as opposed to conventional gel-electrolytes".

In light of the above together with the repeated teachings in Applicants' specification and sworn evidence from Dr. Shembel in her Declaration, Applicants submit that the 35 U.S.C. § 112, first paragraph rejection of claims 1-25 based on lack of enablement for a homogeneous solid electrolyte material should be removed.

Turning now to rejections based on art, Applicants first note that the claims were analyzed without patentable weight in the Final Office Action given to the homogeneous solid electrolyte aspect of the claimed invention. Based on the Examiner discounting the homogeneous solid electrolyte limitation, claims 1-3, 6, 8, 10, 12-15, and 18-22 were rejected under 35 U.S.C. §102(e)/103(a) as being anticipated and alternatively unpatentable over previously cited U.S. Patent No. 6,617,078 to Chia et al. ("Chia '078"). According to the Examiner, "Chia '078 teaches a lithium ion rechargeable battery having a negative electrode, a positive electrode and a separator/polymer electrode there between comprising a chlorinated polymer." Claims 1-3, 6-15, and 18-25 were also rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent No. 5,252,413 to Alamgir et al. ("Alamgir '413") in view of U.S. Patent No. 5,389,463 to Chang et al. ("Chang '463") and/or in view of Chia '078. According to the Examiner, Alamgir teaches "a lithium

battery using lithium ion conductive solid polymer electrolytes composed of solvates of lithium salts immobilized in a solid organic polymer matrix." In addition, according to the Examiner, Chia '078 teaches "a lithium ion rechargeable battery having a negative electrode, a positive electrode and a separator/polymer electrode there between comprising a chlorinated polymer." Finally, the Examiner cited Chang '463 and stated "Chang teaches a polyvinyl halide having a halogen content of at least about 55 % wt of the polymer."

Before reviewing the claim rejections based on art, Applicants will first review the claimed invention as now recited in amended claim 1. Amended claim 1 recites a polymer electrolyte comprising a modified chlorine containing polymer having an enhanced chlorine level relative to a chlorine content of an unmodified chlorine containing polymer formed from polymerization of its monomer, a salt of an alkali metal, and an aprotic solvent. The polymer electrolyte comprises a solid homogeneous material formed by dissolving the salt, the aprotic solvent and the modified polymer material in a common solvent to form a homogeneous solution, and then drying the homogeneous solution to remove the common solvent. Thus, the salt and aprotic solvent (plasticizer) are integrated with the modified polymeric material as a homogeneous (single phase) solid material.

Chia discloses production of a gel electrolyte in two steps. A micro porous film separator is formed by mixing of chlorinated PVC and terpolymer of vinylidene chloride. The terpolymer of vinylidene chloride is used to increase the physical mechanical properties of separator, since the film based on C-PVC is disclosed to be brittle. The separator is impregnated with a 1M solution of $LiPF_6$ in ethylene carbonate and dimethyl

carbonate-based electrolytes. A two phase gel electrolyte is clearly formed, where the electrolyte fills the pores of the polymer.

Chang is entitled "Battery Separator". Chang's separator includes a microporous sheet product having first and second major surfaces and a thickness of less than about 50 mils, formed from a uniform mixture of a halogenated polyolefin polymer and a filler or a halogenated polyolefin polymer and surfactant/filler agent. The sheet product has a fibrous sheet embedded within the mixture and between the first and second major surfaces. Chlorinated PVC is one of the polymers disclosed by Chang.

Chang only discloses a porous separator. The porous separator does not have any significant ionic conductivity. To produce an electrolyte for use in a battery, the porous separator must be impregnated with a liquid electrolyte, where the electrolyte becomes disposed in the pores of the separator. The electrolyte would then provide Li ion conductivity. As a result, Chang's hypothetical impregnated separator would consist of two separate phases analogous to Chia (discussed above):

i. The first phase being a solid porous separator

ii. The second phase being a liquid electrolyte including a salt.

Alamgir discloses lithium batteries using Li ion (Li+) conductive solid polymer electrolytes derived by immobilizing solvates formed between a Li salt and an aprotic organic solvent (or mixture of such solvents) in PVC. Alamgir does not disclose or suggest use of C-PVC. Thus, the PVC used by Alamgir is conventional PVC, not a modified chlorine containing polymer having an enhanced chlorine level claimed by Applicants, such as C-PVC.

In contrast, amended claim 1 recites a polymer electrolyte comprising a modified chlorine containing polymer having an enhanced chlorine level relative to a chlorine content of an unmodified chlorine containing polymer (e.g. C-PVC) formed from polymerization of its monomer, a salt of an alkali metal, and an aprotic solvent. The salt, aprotic solvent (plasticizer) and modified polymeric material are integrated as a homogeneous (single phase) solid material.

Alamgir does not disclose or suggest use of Applicants' claimed modified chlorine containing polymer. Although Chia and Chang do disclose C-PVC, which is a modified chlorine containing polymer, the electrolyte formed is necessarily a conventional gel-electrolyte having a first phase being a solid porous separator and the second phase being a liquid electrolyte including a salt based on the two step processes disclosed. Gel electrolytes are clearly structurally distinct from Applicants' claimed homogeneous solid electrolyte material and provides distinct ionic conductivity performance as testified to in Paragraphs 12 and 13 of the Declaration which include relevant comparative data. In Paragraph 14 Dr. Shembel testifies that "Comparative analysis of the AFM polymer electrolytes based on C-PVC shown above demonstrates that homogeneous single phase electrolytes produced from drying homogeneous solutions according to the '556 application is clearly structurally distinguishable as compared to the multi-phase gel electrolytes formed using separator impregnation with liquid electrolytes as described in Chang and Chia". Accordingly, Applicants submit that amended claim 1 and its respective dependent claims are patentable claims. The rechargeable battery recited in amended claim 12 includes the patentable electrolyte recited in amended claim 1.

Accordingly, Applicants submit that amended claim 12 and its respective dependent claims are also patentable claims.

Applicants have made every effort to present claims which distinguish over the prior art, and it is believed that all claims are in condition for allowance. However, Applicants invite the Examiner to call the undersigned (direct line 561-671-3662) if it is believed that a telephonic interview would expedite the prosecution of the application to an allowance.

Respectfully submitted,

AKERMAN SENTERFITT

Date: March 7, 2005

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West Palm Beach, FL 33402-3188
(561) 653-5000

EXHIBIT "A"

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re: Application of SHEMBEL, et al.

Application No. 10/038,556 Examiner: Dove, Tracy M.

Date Filed: January 4, 2002 Group: 1745

For: SOLID POLYMER ELECTROLYTE LITHIUM BATTERY

CERTIFICATE UNDER 37 CFR 1.8(a)
I hereby certify that this correspondence is being deposited with the U.S. Postal Service as First Class mail in an envelope addressed to the Commissioner for Patents, Alexandria, VA on

3/7/05

Reg. No. 46,803
Neil R. Jetter

RULE 132 DECLARATION

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Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

I, Elena M. Shembel, PhD, declare as follows:

1. I am a named inventor and familiar with patent application No. 10/038,556 entitled " SOLID POLYMER ELECTROLYTE LITHIUM BATTERY" (hereafter the '556 application) and the subject matter described therein.

2. As detailed in the attached cv, I hold a Dr. of Science degree at the Russian Academy of Sciences Institute of Electrochemistry, Moscow for work involved with lithium chemical power sources. I have worked regularly lithium chemical power sources for over 27 years. I am presently the Vice President, Director of Research and Development of Ener1, Inc.

As of the date hereof, Ener1, Inc. is a publicly traded corporation, the stock of which is quoted on the Over-the-Counter Bulletin Board. ENER1, Inc. develops and markets technologies and products for clean, efficient energy sources, including high-energy lithium batteries and components, nanotechnology-based materials and manufacturing processes, and fuel cell system and components.

3. I have more authored or coauthored more than 300 scientific papers, and more than 40 issued patents regarding lithium chemical power sources, many of which are detailed in the attached listing of my publications.

4. I have reviewed the Final Office Action dated October 5, 2004 and references cited therein, including U.S. Patent No. 6,617,078 to Chia et al. ("Chia"), U.S. Patent No. 5,389,463 to Chang et al ("Chang"), and U.S. Patent No. 5,252,413 to Alamgir et al. ("Alamgir").

5. I will first review Chia. Chia discloses production of a gel electrolyte in two steps. A micro porous film separator is formed by mixing of chlorinated PVC and terpolymer of vinylidene chloride. The terpolymer of vinylidene chloride is used to increase the physical mechanical properties of separator, since the film based on C-PVC is disclosed to be brittle. The separator is impregnated with a 1M solution of $LiPF_6$ in ethylene carbonate and dimethyl

carbonate-based electrolytes. A two phase gel electrolyte is clearly formed, where the electrolyte fills the pores of the polymer.

6. I will now review Chang. Chang is entitled "Battery Separator". Chang's separator includes a microporous sheet product having first and second major surfaces and a thickness of less than about 50 mils, formed from a uniform mixture of a halogenated polyolefin polymer and a filler or a halogenated polyolefin polymer and surfactant/filler agent. The sheet product has a fibrous sheet embedded within the mixture and between the first and second major surfaces. Chlorinated PVC is one of the polymers disclosed by Chang.

Chang only discloses a porous separator. The porous separator does not have any significant ionic conductivity. To produce an electrolyte for use in a battery, the porous separator must be impregnated with a liquid electrolyte, where the electrolyte becomes disposed in the pores of the separator. The electrolyte would then provide Li ion conductivity. As a result, Chang's hypothetical impregnated separator would consist of two separate phases analogous to Chia (discussed above):

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7. I now review Alamgir. Alamgir discloses lithium batteries using Li ion (Li+) conductive solid polymer electrolytes derived by immobilizing solvates formed between a Li salt and an aprotic organic solvent (or mixture of such solvents) in PVC. Alamgir does not disclose or suggest use of C-PVC. Thus, the PVC used by Alamgir is conventional PVC, not the

modified chlorine containing polymer having an enhanced chlorine level claimed by Applicants, such as C-PVC.

8. The claimed invention recited in amended claim 1 of the '556 application is a polymer electrolyte comprising a modified chlorine containing polymer having an enhanced chlorine level (e.g. C-PVC), relative to the chlorine content of an unmodified chlorine containing polymer formed from polymerization of its monomer. The polymer electrolyte is a solid homogeneous (single phase) material that includes the modified polymer, a salt of an alkali metal and an aprotic solvent, where all the electrolyte components are uniformly distributed in the electrolyte.

As described in the '556 application, such as page 21, lines 11-15, and Examples 2-6, a low boiling point solvent is used to first dissolve the salt, aprotic solvent (plasticizer) and the modified polymer. Thus, at least two solvents are used. The low boiling point solvent is then removed in a drying process, preferably under vacuum. The concentration of the various polymer electrolyte components and the drying conditions as described in the '556 application are optimized to essentially eliminate any phase separation as the homogeneous solution is dried to form solid homogeneous polymer electrolyte claimed in the '556 application.

Although the aprotic solvent is correctly noted by the Examiner to be by definition, a liquid having a characteristic readiness to flow, when integrated in Applicants' claimed electrolyte with the salt and modified polymer, the solvent is no longer a liquid since it does not have the characteristic readiness to flow which define liquids. Rather, the aprotic solvent can be regarded as being complexed based on its interaction with the other electrolyte components. The solvent which as dried and thus removed in Applicants' process is a low boiling point solvent,

such as THF, which is distinct from the aprotic solvent which is integrated in the electrolyte structure. Accordingly, the arguments provided on page 12 of Applicants' Reply filed on July 19, 2004 are not contradictory as asserted by the Examiner on page 3 of the Final Office Action. When Applicants referred to "The polymer, the salt and the solvent are homogeneously mixed in solution" they were referring to the step prior to drying to form a solid electrolyte layer, such as the "100 mm thick electrolyte layer". The thickness limitation was with reference to the claimed solid polymer electrolyte, not the homogeneous solution.

9. The '556 application does note on page 8, lines 11-13 and page 14, lines 6-8 that "The invention is applicable to both primary and rechargeable lithium batteries, Li metal or Li ion batteries, the polymer electrolyte being either solid or gel polymer types". However, the solid polymer referred to above is the preferred embodiment of the invention comprising a solid homogeneous (single phase) electrolyte including a salt, an alkali metal and an aprotic solvent all uniformly distributed in the electrolyte as claimed in '556 application.

10. As described in detail below, the polymer electrolyte recited in claim 1 is quite distinct structurally when compared to conventional gel polymer electrolytes. Gel structures are multi-phase structures including a polymer first phase, a liquid electrolyte second phase including solvent and Li salt, and often a third salt phase.

11. Although to the best of my knowledge the claimed homogeneous solid electrolyte film based on C-PVC was unknown prior to the present invention, homogeneous solid polymer-

based electrolyte films based on other polymers have been known. I have been informed by Attorney Jetter that the Examiner is only aware of gel-polymer electrolytes.

Although quite uncommon before the present invention, homogeneous solid polymer electrolyte films where all the electrolyte components (salt, solvent and polymer) are uniform distributed in solid electrolyte were known. Recently for development effective and safe Li-battery effort directed to develop solid polymer electrolyte without free volume of solvent. Such arrangements are sometimes referred to as "complexes". More recently, homogeneous solid polymer electrolyte films have been increasingly common due to the improved properties generally provided as compared to multi-phase gel electrolytes. See published U.S. application No. 20040253520 (assigned to Solicore, Inc.).

For example, U.S. Patent No. 5,609,974 to Sun discloses a homogeneous solid polymer electrolyte film without phase separation. As noted in Sun's background "solid polymer electrolytes have been proposed in the past for use in place of liquid electrolytes in such equipment because they combine in one material the function of electrolyte, separator, and binder for the electrode materials, thereby reducing the complexity of the ultimate structure". Sun forms the homogeneous solid polymer electrolyte film first dissolving an electrolyte salt in a solution including a combination of selected monomers together with a plasticizer and then spreading the solution into a thin layer whereupon the layer is heated or otherwise subjected to a source of energy to effect its polymerization. The polymerization of this solution results in the formation of a homogeneous solid polymer electrolyte film without phase separation (see the first two paragraphs of the detailed description). Although Sun's method is more complex and quite different as compared to the method disclosed in the present application, the single phase homogeneous solid polymer electrolyte disclosed by Sun comprising polymer, salt and solvent is

analogous to the electrolyte claimed in the '556 application in that a single phase electrolyte is provided, as opposed to conventional gel-electrolytes.

12. I provide some analytical data below to demonstrate the differences between the claimed homogeneous polymer electrolyte and the gel electrolytes disclosed in the Chia and Chang, Chia and Chang being the only cited art that discloses C-PVC for polymer electrolyte. Below, in Figs. 1 and Fig. 2 I provide atomic force microscopy (AFM) data for C-PVC-based polymer electrolytes films produced according by the invention and the cited art (Chia and Chang), respectively.

In Fig. 1, the structure analyzed was formed from a lithium salt ($LiCF_3SO_3$) solution in an aprotic solvent (PC) which was added into previously prepared C-PVC solution in tetrahydrofuran (THF). Solutions, prepared in this fashion, were poured onto a glass support and dried, first at room temperature for 24 h and then in a vacuum at 45°C for 48 h. These steps follow the method described in the '556 application. The resulting electrolyte films are solid-phase homogeneous systems that have a uniform distribution of the all components in electrolyte as shown in Fig. 1 below.

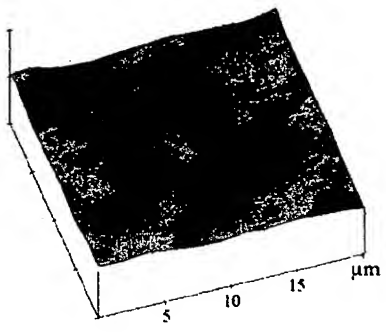

Fig. 1 AFM of homogeneous film electrolyte of composition C-PVC:PC:0.5M $LiCF_3SO_3$

13. The method of electrolyte preparation described in Chang and Chia include the steps of production of microporous solid separator based on C-PVC formed by drying from polymer solution in tetrahydrofuran, impregnation of the produced separator with a liquid electrolyte, which is 0.5M solution of $LiCF_3SO_3$ in propylene carbonate, and followed by drying the produced polymer electrolyte at room temperature for 24 h and then in a vacuum at 45°C for 48 h.

The films produced by the method of Chang and Chia were found to have a rough surface evidenced by the AFM shown in Fig. 2, where the respective electrolyte components were distributed non-uniformly (Fig. 2), and where individual crystallites of the $LiCF_3SO_3$ salt exited the surface of the electrolyte.

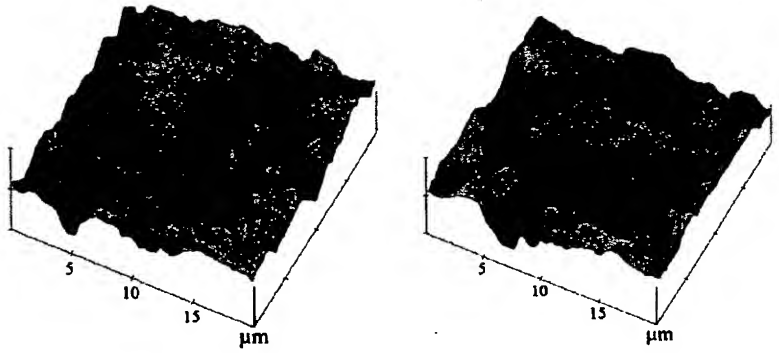

Fig. 2 AFM of non-homogeneous polymer electrolytes, obtained from the C-PVC -based separators (various samples of polymer electrolytes)

14. Comparative analysis of the AFM polymer electrolytes based on C-PVC shown above demonstrates that homogeneous single phase electrolytes produced from drying homogeneous solutions according to the '556 application is clearly structurally distinguishable as compared to the multi-phase gel electrolytes formed using separator impregnation with liquid electrolytes as described in Chang and Chia.

15. The homogeneous single phase nature of the homogenous (single phase) electrolyte claimed in the '556 application which comprises the polymer, the salt and some aprotic solvent being intimately mixed is also evidenced by the high ionic conductivity values obtained by Applicants, such as the lithium ion conductivity of up to .108 S/cm^2 disclosed in the application (Example 6, page 26, line 2). For a 100 μm thick electrolyte layer, the resulting Li ion conductivity would be 1.08×10^{-3} S/cm. The high ionic conductivity values obtained provide further evidence of the single phase electrolyte, since phase separation would reduce the ion conductivity towards values provided by conventional gel-electrolytes which are multi-phase structures.

16. I further state that all statements made herein are of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with my knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under §1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Dr. Elena M. Shembel

March 7, 2005
Date

SHEMBEL, Olena (Elena) M.

Dr. Elena Shembel is Vice President, Director of Research and Development of Enerl, Inc. http://www.enerl.com (Ft. Lauderdale, FL).
Dr. Shembel has over 27 years of experience in the field of chemical power sources, especially, lithium primary and secondary batteries. For 18 years Dr. Shembel has been the head of various laboratories and projects, which have investigated, developed and introduced lithium power sources into industrial production. Dr. Shembel acquired her Ph.D. in electrochemical processes for systems with porous matrixes for space systems. In 1989 Dr. Shembel acquired her Dr. of Science degree at the Russian Academy of Sciences Institute of Electrochemistry, Moscow for her work in processes and optimization of lithium chemical power sources. Dr. Shembel has published more than 300 scientific papers, and has granted more than 40 patents. Dr. Shembel routinely presents scientific papers at numerous international meetings and is a member of American Electrochemical Society, International Electrochemical Society and American Society for Nondestructive Testing.

Scientific Degree: Doctor of Chemical Sciences

EMPLOYMENT

2002–present	Enerl, Inc., Fort Lauderdale, Florida, USA (www.enerl.com)
	Vice President, Director of Research and Development
2000–2002	Enerl, s.r.l., La Spezia, Italy
	Director of Research and Development
1989-2000	Ukrainian State Chemical Technology University, Dnipropetrovsk,
	Head of the Chemical Power Sources Research Laboratory
1983-1989:	Dnipropetrovsk Chemical Technology Institute, Ukraine
	Group Leader
1980-1983:	Dnipropetrovsk Chemical Technology Institute, Ukraine
	Senior Research Associate
1975-1980:	Dnipropetrovsk Chemical Technology Institute, Ukraine
	Research Scientist

Major activity - Investigations of electrochemical processes in non-aqueous systems, development of high-energy primary and secondary lithium power sources with solid-phase and liquid-phase oxidizers, liquid-state and polymer electrolytes.

EDUCATION and SCIENTIFIC DEGREES

1989 Institute of Electrochemistry, Moscow
Doctor Science Degree: "Processes in lithium chemical power sources and the ways of their optimization".

1974 Dnipropetrovsk Chemical Technology Institute, Ukraine
Ph.D. Degree: "Electrochemical processes in systems with porous matrixes".

1964–1969 Dnipropetrovsk Chemical Technology Institute
M.S. Chemist-technologist.

MANAGEMENT OF INTERNATIONAL GOVERNMENTAL AND COMMERCIAL PROJECTS

Currently Dr. Shembel manages about 60 researches (14 Ph.D.) which are either employees of Enerl Inc. or participants of the current international scientific projects directed by Dr. Shembel.

2003-present Technical leader of the Thrust II project No 323130AF-II "Development of New Lithium Metal Secondary Battery with Polymer Electrolyte and Cathode Based on Metal Oxides" ", executed within the framework of Initiatives for Proliferation Prevention (IPP) Thrust I program of the U.S. Department of Energy (www.energy.gov) jointly with Pacific Northwest National Laboratory (www.pnl.gov), USA. The project involves research, development, prototyping and production of new lithium-metal secondary batteries with polymer electrolytes and cathodes based on metal oxides. U.S. Department of Energy is providing $798,000 in funding the project in two equal annual funding installments. The results of the project are expected to enhance Enerl R&D position, as well as its U.S. and overseas production and raw material capabilities as the company prepares to commence prototype production at its new $20 million plant in Ft. Lauderdale, Florida.

August 2003-present Project Manager/Principal Investigator of the SBIR Contract No. N00164-03-C-6029 , Sponsor: Missile Defense Agency
"Thin Layer Sulfide – Based Cathode for High Energy Density Lithium Batteries With Solid Inorganic or Polymer Electrolyte

2001-2003 Principal Manager of the project No. 1810 "Development of Polymeric Lithium Rechargeable Battery Based on a Nanostructured Pyrite Cathode" financed from

USA and Europe by Science and Technology Centre In Ukraine, Kiev (www.stcu.int). The project is devoted to the development of a principally new lithium power source with high operational characteristics and its further commercialization in the U.S. Enerl, Inc (www.enerl.com) is one of the official collaborators of the project.

2000-present Principal Manager of the project No. USO-1207 "Development of Lithium High Energy Power Source with the Cathode Based on Vanadium Oxides and Polymer Electrolyte" financed by Enerl, Inc. (www.enerl.com) with the framework of the U.S. Civilian Research and Development Foundation (www.crdf.org). The goal of the project is the development of lithium secondary battery with polymer electrolyte and anode based on vanadium oxides.

2000-2002 Principal Scientific Manager of the project "Development and Evaluation of the Ukrainian Primary and Secondary Lithium Power Sources", executed within the framework of Initiatives for Proliferation Prevention (IPP) Thrust I program of the U.S. Department of Energy (www.energy.gov) jointly with Pacific Northwest National Laboratory (www.pnl.gov), USA. During project execution the prototypes of lithium batteries with polymer electrolyte were manufactured and successfully tested at the U.S. Department of Energy.

2000-2002 Principal Scientific Manager of the project No. USO-1200 "Development of Inorganic Solid State Electrolytes for Rechargeable Lithium Thin-Film Battery System" financed by Samsung SDI (www.samsung.com) with the framework of the U.S. Civilian Research and Development Foundation (www.crdf.org). The goal of the project was the development of a thin high performance lithium battery with vitreous inorganic electrolyte having a high conductivity at room temperature and stability under the operation conditions (resistance, temperature, etc).

1999-2000 Principal Manager of the project No.656 "Development and Production of High-Energy Lithium Secondary Batteries" financed from USA by Science and Technology Centre in Ukraine (www.stcu.int). During project execution the investigations and developments of lithium power sources based on Ukrainian raw materials (manganese dioxide and graphite) were carried out.

1998-2000 FSU Principal Manager of the project No. USB-384 financed jointly by the U.S. Civilian Research and Development Foundation (www.crdf.org) and US Nanocorp, Inc (www.usnanocorp.com). The main objectivities of the project included: the development of highly-efficient production method of thin-layer cathode based on natural and synthesized pyrite and elaboration on its basis the

promising electrochemical system, cycleable at room and low temperatures.

PROFESSIONAL ACTIVITY:

2000 – present **Ener1, Inc., Fort Lauderdale, Florida, USA**
(till 2002 – Ener1 s.r.l., La Spezia, Italy)

Director of Research and Development

Investigation, development and optimization of primary and secondary lithium high-energy chemical power sources with non-aqueous electrolyte and solid-phase oxidizers ($LiMn_2O_4$, V_2O_5, FeS_2, MnO_2, CuO, CFx and others). Anodes based on volume and surface lithium alloys and graphite (Li-ion system). Corrosion processes in lithium chemical power sources. The development and the production method for cathodes, anodes, polymeric and solid electrolytes, cell assembly. Cylindrical and flat power sources. Testing methods.

1969 – 2000 **Ukrainian State Chemical Technology University, Dnipropetrovsk, (previous name till 1993 - Chemical Technology Institute)**

1994-2000 Development of lithium systems, operating in a buffer regime of recharging from solar cells (contract with National Space Agency of Ukraine). The development of lithium power sources for the replacement of Zn-HgO power sources. The development of electrochemical and chemical synthesis methods for the solid-phase cathode oxidizers (vanadium, cobalt, manganese oxides for lithium power sources). Investigation and development of the synthesis methods for polymer electrolytes (contract with Ukraine Ministry of science). Development of the concept and technological implementation to use Ukrainian raw materials (manganese ores, natural graphite) for the development and production of lithium batteries.

1991-1994 Investigation and development of electrochemical system Li-SO_2 for high-energy lithium secondary battery (jointly with Accumulator Institute, Leningrad). Participation in the industrial production of small-size Li-FeS_2 primary power sources of button design (Stock Company NCCP, Novosibirsk). Development of the production technology of primary power sources of spiral construction of cylindrical «AA»- and «C»- size cells based on Li-FeS_2 and Li-MnO_2 systems with improved specific energy characteristics and long shelf life. Jointly with NCCP (Novosibirsk, Russia) the development and patenting of surface lithium alloys for lithium power sources.

1986-1991 Development of the catalysts for SO_2 cathode reduction (jointly with the Institute of Electrochemistry of AS of the USSR, Moscow). Technology development for the purification of natural pyrite (Kazakhstan deposits) cathode material for lithium batteries. Development of the technology, design, and production of cylindrical power sources of Li-FeS_2 system on industrial scale (contract with "Impuls" plant, Velikiye Luki, Pskov Region, Institute of power Sources, Moscow and Watch Plant, Orel).

1983-1986 Development of electrochemical systems for lithium batteries to increase power and capacity. Optimization of cathode macrostructure for Li-SO_2 and Li-$SOCl_2$ batteries. Development of the production technology of power sources. (contract with The Institute of Power Sources, Moscow.)

1979-1983 Development of electrochemical system Li-FeS_2 for the replacement of traditional Zn-Ag_20 system in quartz watch (contract with the Dept. of USSR Watch Industry, joint collaboration with Accumulator Institute, Leningrad, KP PS, Kusa, Chelyabinsk Region,

Ural). Investigation of the impedance characteristics of the lithium/non-aqueous electrolyte interface, description, modeling and the calculation of the equivalent of circuit process.

1975-1978 Investigation of physical and chemical properties of non-aqueous electrolytes based on different aprotic solvents containing SO_2. Investigation of the kinetics and macrokinetics of SO_2 cathode reduction from non-aqueous electrolytes. Studies of electrochemical processes at the lithium/non-aqueous electrolyte (containing SO_2) interface. Development of Li-SO_2 electrochemical system, optimization of electrolyte composition, mathematical modeling of transient processes at power source discharge, optimization of material balance (contract with Accumulator Institute, Leningrad, joint developments and patent prosecution in the U.S., England, France, Germany, Italy and India).

1969-1974 Development of insoluble anodes for the production of chlorine and oxygen by electrolysis in aqueous solution. (Contract with the Institute of Chlorine Industry of the USSR). Investigation, experimental and mathematical modeling of transient processes in porous electrodes and separators. The development of electrochemical methods of water regeneration under zero gravity conditions (space equipment) (Contract with the Institute of Medicine-Biological Problems, Moscow).

PRESENTATIONS AT INTERNATIONAL CONFERENCES as presenting author

(for details please see the list of publications):

- **USA**
  - Fort Lauderdale, 2004, 2003, 2002, 2001, 2000
  - Monterey, 2002, 2003
  - Philadelphia, 2002
  - Salt Lake City, 2002
  - Washington, 2001
  - San Francisco, 2001
  - Phoenix, 2000
  - Seattle, 1999
  - Boston, 1998, 1994
  - San Antonio, 1996
- **Germany** (Dusseldorf , 2002; Munster, 1992)
- **Chezh Republic** (Brno, 2002)
- **France** (Bordeaux – Arcachon, 2001; Annecy, 1998; Paris, 1997)
- **Netherlands** (Amsterdam 2003, Noordwijkerhout, 2001,)
- **Poland** (Cracow, 2001)
- **England** (Manchester, 2001, Brighton, 1999; Brighton, 1995; Stratford, 1993)
- **Italy** (Como, 2000)
- **Canada** (Toronto, 2000)
- **Marocco** (Marrakesh, 1999)
- **Scotland** (Edinburgh, 1998)

- **Chine** (Tianjin, 1992)
- **Bulgaria** (Sophia, 1989)

MAIN RESEARCH INTERESTS:

- Electrochemical Kinetics;
- Macrokinetics of electrochemical processes in porous systems (in electrodes and separators);
- Physical and Chemical Properties of non-aqueous Electrolytes;
- Mathematical modeling of transient processes in electrochemical systems;
- Impedance characteristics of Electrochemical Systems;
- Investigations and Developments of Lithium Chemical power sources;
- Lithium-Metal and Lithium-ion systems with liquid, polymer and solid electrolytes

SCIENTIFIC PUBLICATIONS

More than 300 scientific publications including Ph. D. and Dr. of Sci. degree thesisis, 1 monograph, more than 40 issued and pending patents both in the US and abroad, numerous papers in scientific journals and in proceedings of the international conferences. For details see the list of selected scientific publications.

SHEMBEL, Olena (Elena) M.
Dr. of Chem. Sci.

Selected scientific publications

(selected among 300 publication)

More than 300 scientific publications including Ph. D. and Dr. of Sci. degree theses, 1 monograph, more than 40 issued and pending patents both in the US and abroad, numerous papers in scientific journals and in proceedings of the international conferences.

Ph. D. THESIS

1. Electrochemical processes in systems with porous matrixes. Dnipropetrovsk, Ukraine, 1974.

DR. OF SCI. DEGREE THESIS

2. Processes in lithium chemical power sources and the ways of their optimization. Institute of Electrochemistry, Moscow, 1989.

MONOGRAPHS

3. Ksenzhek O. S., Shembel O. M., Kalinovsky E. A. et al. Electrochemical processes in a system with porous matrixes. Vyscha Shkola, 1983, 219 P.

PATENTS

4. USA Pat. 4397921. Electrochemical cell containing sulfur dioxide as cathodic depolarizer / O. S. Ksenzhek, E. M. Shembel, V. I. Litvinova et al.
5. France Pat. 2513019. Element electrochimique contant du dioxide de solfure depolarisant cathodique / O. S. Ksenzhek, E. M. Shembel, V. I. Litvinova et al.
6. India Pat. 1552921. Electrochemical cell containing sulfur dioxide as cathodic depolarizer / O. S. Ksenzhek, E. M. Shembel, V. I. Litvinova et al.
7. Great Britain Pat. 2103870. Electrochemical cell / O. S. Ksenzhek, E. M. Shembel, V. I. Litvinova et al.
8. Italy Pat. 1137895. Elemento Electrochimico contante di zolfo come depolarizzatore cathodico / O. S. Ksenzhek, E. M. Shembel, V. I. Litvinova et al.
9. Germany Pat. DE 3134060. Elektrochemische Element, enthaltend Schweldioxid als Katoden Depolarisator /O. S. Ksenzhek, E. M. Shembel, V. I. Litvinova et al.
10. Germany Pat. DE 31 53 344. Elektrochemische Element, enthaltend Schweldioxid als Katoden Depolarisator /O. S. Ksenzhek, E. M. Shembel, V. I. Litvinova et al.

11. Russian Pat. 2096866 / Anode for chemical power source./ E. M. Shembel, A. I. Belosokhov, V. L. Afanas'ev, et al.

12. Russian Pat. 2157023/ Production method of power source cathode / E. M Shembel, V. M. Nahirniy, R. D. Apostolova.

13. Russian Pat. 2157024 /Production method of the inert cathode for lithium power sources / E. M Shembel, V. M. Nahirniy, R. D. Apostolova

14. Russian Pat. 2157025 / Production method of the cathode for lithium chemical power sources /E. M Shembel, V. M. Nagirny, R. D. Apostolova

15. Production method of a cathode for lithium chemical power sources. Inventors: Elena Shembel, Victor Nagirny, Raisa Apostolova, Date of application: October 20, 1995. Application No.: 95104595. Declaration Patent No. 17368A. Issue date: April 15, 1997

16. Production method of an inert cathode for lithium chemical power sources. Inventors: Elena Shembel, Victor Nagirny, Raisa Apostolova, Date of application: July 20, 1995. Application No.: 95073427. Declaration Patent No. 20790A. Issue date: October 7, 1997

17. Production method of a cathode for chemical power source. Inventors: Elena Shembel, Victor Nagirny, Raisa Apostolova, Date of application: July 20, 1995. Application No.: 95073418. Declaration Patent No. 20866A. Issue date: October 7, 1997

18. Measurement Method of an Ionic Conductivity of Solid Electrolytes. Inventors: Vladimir Redko, Vladimir Khandetsky, Elena Shembel, Peter Novak. Date of application: December 11, 2001. Application No.: 2001128503. Declaration patent No. 45293A. Issue date: March 15, 2002. Number of the International PCT Application: PCT/UA02/00043 of September 05, 2002.

19. Lithium Secondary Batteries with Non-aqueous Electrolyte. Inventors: Elena Shembel, Victor Nagirny, Raisa Apostolova, Peter Novak. Date of application: December 11, 2001. Application No.: 2001128504. Declaration Patent No. 45294A. Issue date: March 15, 2002.

20. Method for eddy-current test of powder material. Investors: Vladimir Khandetsky, Vladimir Redko, Elena Shembel, Peter Novak. Date of application: December 4, 2002. Application No.: 2002129690. Declaration patent No.54354A. Issue date: February 15, 2003. Number of the International PCT Application: PCT/UA03/00022 of June 27, 2003.

21. Production method of active cathode material for lithium secondary batteries. Inventors: Elena Shembel, Victor Nagirny, Raisa Apostolova, Peter Novak. Date of application: July 25, 2003. Application No.: 2003077001. Declaration Patent No. 60953A. Issue date: October 15, 2003.

22. Method for non-contact measuring electrical conductivity of electrolyte by primary transducer Investors: Vladimir Redko, Vladimir Khandetsky, Elena Shembel, Peter Novak. Date of application: July 25, 2003. Application No.: 2003077005. Declaration patent No.60954A. Issue date: October 15, 2003.

23. Method for non-contact measuring electrical conductivity of polymer electrolyte films by combined transducer. Investors: Vladimir Redko, Vladimir Khandetsky, Elena Shembel, Peter Novak. Date of application: July 25, 2003. Application No.: 2003077006. Declaration patent No. 60955A. Issue date: October 15, 2003.

24. Method of Non-Destructive Control of Hermiticity Based on Gas-Discharge Visualization Investors: Vladimir Redko, Elena Shembel, Peter Novak. Date of application: July 25, 2003. Application No.: 2003077007. Declaration patent No. 64623A. Issue date: February 02, 2004.

US pending patents

25. Solid Polymer Electrolyte Lithium Battery. E.Shembel, O.Chervakov, P.Novak. Patent Application No.10/038,556. Filed 01/04/02.
26. Nonaqueous Electrolytes Based on Organosilicon Ammonium Derivatives for High-Energy Power Sources. E.Shembel, O.Chervakov, N.Globa, P.Novak. Filed 04/19/02.
27. Salts of Alkali Metals of N, N'-Disubstituted Amides of Petane Iminosulfonic Acid and Nonaqueous Electrolytes on their Basis. E.Shembel, O.Chervakov, I.Koval, T.Oliynik, P.Novak. Filed 04/15/02.
28. Methods and Installation for Thin Films Production. Ye.Kalynushkin, E.Shembel, P.Novak, C.Flury. Patent Application No. 10/108,140. Filed 03/27/02.

Pending patents abroad

29. Solid Inorganic Glassy Electrolyte and Production Method Thereof . Inventors: Elena Shembel Alexander Nosenko, Andrey Kvasha, Peter Novak Patent Application No. 2003077008, Filed 07/25/03
30. Carbon Material for Electrodes of Lithium-Ion Power Sources and Method of Production Thereof. Inventors: Yury Pustovalov, Elena Shembel, Leon Vishnyakov, Natalya Globa, Igor Sagirov, Nelya Zaderey, Peter Novak. Patent Application No. 2003077002 Filed 07/25/03
31. Method and Device for Rapid Charging Secondary Power Sources. Inventors: Anataliy Alpatov, Ivan Sokolovsky, Elena Shembel, Peter Novak. Patent Application No. 20031110308, Filed 07/25/03
32. Manganese dioxide for the cathodes of lithium power sources. Inventors: Elena Shembel, Vasiliy Pisniy, Natalya Globa, Nelya Zaderey, Peter Novak. Patent Application No. 20031212437, Filed 12/25/03
33. Production method of lithium battery. Inventors: Elena Shembel, Yevgeniy Kalinushkin, Peter Novak, Alexander Markevich, Alexander Balakin. Patent Application No. 2003077004 Filed 07/25/03

USSR Inventor's Certificates

34. No 947224 Kalinovsky Ye. A., Shustov V.A., Shembel E.M., et al.
35. No 1005218 Ksenzhek O. S., Shembel O. M., Litvinova V. I., et al.
36. No1276981 Ksenzhek O. S., Shembel O. M., Maksyuta I. M. et al.
37. No 1294244 Shembel O. M., Danilova N.P., Ksenzhek O. S., et al.
38. No 1354603 Shembel O. M., Ksenzhek O. S., Danilova N.P., et al.
39. No 1376864 Shembel O. M., Danilova N.P., Ksenzhek O. S., et al.
40. No 1412537 Shembel O. M., Danilova N.P., Ksenzhek O. S., Maksyuta I. M.
41. No 1473652 Danilova N.P., Shembel O. M., Ksenzhek O. S., et al.
42. No 1512440 Strizhko A. S., Shembel O. M., Ksenzhek O. S., et al.
43. No 1558268 Strizhko A. S., Malkov Y.M., Shembel O. M., et al.
44. No 1694025 Strizhko A. S., Shembel O. M., Ksenzhek O. S., et al.
45. No 1699319 Strizhko A. S., Shembel O. M., Ksenzhek O. S., et al.
46. No 1769650 Garkusha Y.A.,Danilova N.P., Shembel O. M.

JOURNAL PUBLICATIONS AND PROCEEDINGS OF THE CONFERENCES

47. Shembel O. M., Litvinova V. I., Maksyuta I. M. et al. Cathodic reduction of sulfur dioxide in non-aqueous electrolytes. Solution of lithium perchlorate in propylene carbonate // Elektrokhimiya. - 1978. - T. 15. – P. 1671-1677.

48. Shembel O. M., Litvinova V. I., Maksyuta I. M., Ksenzhek O. S. Cathodic reduction of sulfur dioxide in non-aqueous electrolytes. Correlation comparison of perchlorate and bromide solutions // Elektrokhimiya. - 1979. - T. 15. - P. 1791-1795.

49. Ksenzhek O. S., Shembel O. M. Electrochemical processes in a high power Li-SO power sources // J. Power sources. - 1983. - v. 10. -P. 377-387.

50. Shembel O. M., Ksenzhek O. S., Danilova N. P. Cathodic reduction of sulfur dioxide in non-aqueous electrolytes. polarization curve on a porous electrode // Elektrokhimiya. - 1985. - T. 21. - C. 1265-1263.

51. Shembel O. M., Strizhko A. S., Vasilyeva E. A. et al. Cathodic reduction of pyrite in non-aqueous electrolytes. Porous electrode // Elektrokhimiya. - 1985. - T. 21. - C. 1560-1562.

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53. Shembel O. M., Ksenzhek O. S., Maksyuta I. M. Analysis of the impedance measurements on lithium electrode from the stand point of the semiconductor nature of the passivating film. Lithium perchlorate solution in propylene carbonate // Elektrokhimiya. - 1986. - T. 22. - C. 446-451.

54. Shembel O. M., Ksenzhek O. S., Strizhko A. S. et al. Cathodic reduction of pyrite in non-aqueous electrolytes. Electrode reaction // Elektrokhimiya. - 1986. - T. 22. - C. 824-828.

55. Shembel O. M., Ksenzhek O. S. Investigation of the influence of non-aqueous solvent nature on the cathodic reduction of sulfur dioxide // Elektrokhimiya. -1986. -T. 22. -C. 1680-1684.

56. Shembel O. M., Ksenzhek O. S., Lobach G. A., Litvinova V. I. Cathodic reduction of sulfur dioxide in non-aqueous electrolytes. Influence of solution composition on the diffusion coefficient of sulfur dioxide // Elektrokhimiya. -1986. - T. 22, N3. - C. 419-421.

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